

Leadership Substitutes and Personality Impact on Time and Quality in Virtual New Product Development Projects

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ABSTRACT ■

Leadership, personality, and organizational factors were analyzed to measure their combined effect on virtual-based product development time and scope-quality performance. Over 1,000 team members were surveyed. MANCOVA was used to test if leadership, personality project, and/or organizational factors impacted performance. All realistic factors were included to detect leadership substitutes moderation, mediation, and prediction. Bias was reduced by not surveying leaders, by using reverse item coding, and by checking social desirability. Experimental control and common method variance were managed by including multilevel and multisource data. Performance was objectively computed from organizational data. The findings were that transactional leadership (not transformational) and some personality attributes (leader substitutes) were significant factors, increasing project scope quality and time performance.

KEYWORDS: virtual product development; transformational transactional leadership; leadership substitutes; personality; competencies; time performance; scope quality

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INTRODUCTION ■

Transformational leadership is an important factor impacting virtual new product development (NPD) project success (Aronson, Reilly, & Lynn, 2006; Durmusoglu, Calantone, & Sambamurthy, 2006; Kodama, 2005; Lampel, Scarbrough, & Macmillan, 2008; Sheard & Kakabadse, 2004; Song & Noh, 2006; Tsai & Huang, 2008; Valle & Avella, 2003; Wouters, Anderson, Narus, & Wynstra, 2009). Transformational leadership seems essential in virtual team contexts in which interpersonal competencies are challenged by staff dispersion (Barczak, McDonough, & Athanassiou, 2006; Kahai, Fjermestad, Zhang, & Avolio, 2007; Sosik, 2005; Strang, 2008).

Transformational leadership is an important discipline to investigate in new product development because, according to a recent Product Development Management Association survey, “best practices research still has not been able to supply clues, let alone answers, on how to organize most effectively for NPD” (Barczak, Griffin, & Kahn, 2009, p. 22). Cooper and Edgett (2008, p. 48) note, “There is strong evidence that NPD productivity is heading in the wrong direction [down].” Likewise, “research on leadership in virtual teams has not kept pace with the growth of virtual teams” (Kahai et al., 2007, p. ii). Nevertheless, some international studies have found that virtual team performance was impacted by leadership (Barczak et al., 2006; Keegan & Hartog, 2004; Lok & Crawford, 2004; Patanakul & Milosevic, 2006; Sosik, 2005) or by interpersonal dimensions that can be assessed through personality characteristics (Aronson et al., 2006; Tsai & Huang, 2008; Wouters et al., 2009).

Although transformational leadership is a well-documented topic, the literature may not always be reliable (or generalizable) when evidence consists of single-source data, self-reports, and/or follower perceptions (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003; Werth, Markel, & Förster, 2006; Yukl, 2006). The studies cited above used subjective self-rated criteria; thus, one cannot generalize those findings to NPD business performance. Comparable project leadership studies that leveraged objective criteria have used either small sample sizes (e.g., Strang, 2007) or unknown (invalidated) constructs (e.g., Pentina & Strutton, 2007). Another shortcoming argued here is that very few studies have integrated both leadership and personality theories while also addressing experimental control as well as capturing objective performance measures.

The purpose of this study was to explain how much team leadership or substitutes impacted virtual NPD performance. To achieve that, numerous items were

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gathered from team members through surveys or from organizational data (some of the latter as controls). Two NPD project efficiency indices were selected as performance measures. The ideology was to assess NPD performance based on many realistic factors and substitutes, rather than focusing on a few specific transformational leadership or personality (interpersonal) constructs. The counterargument is acknowledged that "testing every possible interaction by regressing every criterion on all leader behaviors and moderators does not move the substitutes field forward" (Dionne, Yammarino, Howell, & Villa, 2005, p. 170), but the goal in this research was to realistically assess the virtual team leadership effect on relevant NPD project performance metrics.

Literature Review

Virtual NPD projects differ in nature across industries and compared with non-NPD endeavors; yet, they have similar generic project characteristics, such as sponsors, leaders, specialists (team members), quality standards, scope goals, time frames, budgets, and start and end dates (Beaume, Maniak, & Midler, 2009; Pons, 2008). Therefore, this study can draw upon multidisciplinary theories beyond NPD such as transformational leadership, personality, and project management. The following sections examine the literature on transformational leadership, NDP project-level substitute factors, personality factors, and NDP performance.

NPD Team Transformational Leadership Factors

Transformational leadership is usually organized in a construct composed of five to six factors that describe the leader traits and/or interpersonal competencies (personality traits) used to influence and guide a team. The factors can be viewed on a continuum (B. M. Bass & Avolio, 1990), starting with transformational leadership at the top and ending with nonleadership characteristics on the bottom scale. Transformational leadership is usually characterized as the four top-most factors of idealized influence

(charisma), inspirational motivation, intellectual stimulation, and individual consideration. Idealized influence refers to promoting values and/or beliefs, considering moral and ethical consequences of decisions, emphasizing the importance of having a collective sense of mission and/or purpose, and championing exciting new possibilities (B. Bass & Avolio, 2004).

Inspirational motivation is defined as articulating an appealing vision of the future, challenging team members with high standards, talking optimistically and enthusiastically, as well as providing encouragement and meaning for what needs to be done (B. Bass & Avolio, 2004). Intellectual stimulation is associated with questioning old assumptions (traditions or beliefs), encouraging new perspectives or ways of doing things, and advocating the free expression of ideas and reasons (B. Bass & Avolio, 2004). Leaders demonstrate individualized consideration by focusing on individual team member needs, abilities, and aspirations; they listen attentively, as well as attempt to coach, advise, and teach team members (B. Bass & Avolio, 2004). NPD teams usually benefit from intellectual stimulation, individual consideration, and inspirational motivation (Jassawalla & Sashittal, 2000; Lampel et al., 2008; Mumford, Scott, Gaddis, & Strange, 2002; Sarin & McDermott, 2003).

As noted earlier, the transformational leadership components (charisma, inspirational motivation, intellectual stimulation, and individualized consideration) have been proven to positively impact individual follower, team (group), and/or organizational level outcomes (Dumdum, Lowe, & Avolio, 2002; Dvir, Eden, Avolio, & Shamir, 2002; Eisenbeiss, Knippenberg, & Boerner, 2008; Hinkin & Tracey, 1999; J. M. Howell, Neufeld, & Avolio, 2005; Keegan & Hartog, 2004; Kelloway, Barling, Kelley, Comtois, & Gatien, 2003; Strang, 2005).

The next lower dimension of team leadership is contingent reward (also called transactional leadership), which is an exchange process between the leader

and team members, whereby effort by followers is rewarded with a promise of recognition and/or remuneration (but failure could result in punishment). Nonleadership (*laissez-faire*, active/passive management-by-exception) refers to corrective criticism, negative feedback, and negative reinforcement. If the follower perceives this criticism as helpful it could increase performance, and vice versa. A leader using the passive approach would only intervene in critical circumstances. It is posited here that the principles found in active and passive management-by-exception would also be found in transactional leadership (Judge & Piccolo, 2004; Podsakoff, Bommer, Podsakoff, & MacKenzie, 2006), and thus should not be measured twice (or separately). In similar fashion, it is argued that nonleadership is more likely a substitute or personality factor and is discussed later. Other researchers have taken this approach to collapse the lower levels of the leadership factor scales into a single dimension called transactional leadership.

The majority of studies cited earlier demonstrated that contingent reward leadership is positively related to satisfaction, effectiveness, and/or performance. Nevertheless, in some studies, contingent reward was not found to be related to performance (Judge & Piccolo, 2004; Yukl, Gordon, & Taber, 2002) or it negatively predicted performance (J. M. Howell et al., 2005). In a study using online technology, team members of transformational leaders produced less output but of higher quality, were more satisfied, displayed greater cohesiveness, trusted their leader more, and showed greater value congruence than followers of transactional leaders (Hoyt & Blascovich, 2003). Thus, in that case, transformational leadership was more effective than transactional leadership. The consensus is that high transformational leadership usually results in higher performance compared with high transactional leadership (Avolio, Bass, & Jung, 1999; Yukl et al., 2002). Nonetheless, the NPD literature

confers that transactional leadership could either increase or decrease team outcomes (Amabile, Hadley, & Kramer, 2002; Barczak & McDonough, 2003; Pinnington & Haslop, 1995; Sheard & Kakabadse, 2004; Strang, 2007). Thus, the first hypothesis emerges from the above and is described below:

Hypothesis 1: High transformational leadership results in high NPD team performance.

NPD Project-Level Substitute Factors

Contrary to “everything that is not leadership is not a substitute for leadership” (Dionne et al., 2005, p. 181), those “other factors” (such as NPD project and organizational characteristics) are tested here as substitutes with respect to impact on performance. Another term, “moderator,” has risen and refers to interaction effects when specific levels of a factor affect other leadership variables, but the factor itself does not impact performance. Mediators are similar in that they correlate with leadership factors but also directly impact performance (J. P. Howell, Dorfman, & Kerr, 1986). Nonetheless, NPD projects appear to be prime candidates for true substitutes because they involve highly creative professionals, yet there are fewer conditions that would give rise to enhancers, neutralizers, or moderators. This is mainly a situational assertion, because here the interest is on the direct NPD team effect on performance (as per earlier feedback from executives).

It was the well-known Kerr and Jermier (1978) study that articulated leadership substitutes by measuring leader “perceptions” of eight situational variables during “athletic coaching experiences”: ability/skills, professional orientation, organizational formality, organizational flexibility, advisory staff availability, group cohesion, leader lack of reward control, and spatial distance from the leader. Despite the fact that these were leader perceptions (from coaches), these factors have been found to impact performance (J. M. Howell

et al., 2005; J. P. Howell & Dorfman, 1981; J. P. Howell et al., 1986; Manz & Simms, 1980; Podsakoff, MacKenzie, & Bommer, 1996). It is asserted here that substitutes (along with other factors and controls from the organizational data) could predict NPD team performance, equally or more so than the leadership dimensions.

Team-member ability, experience, training, and knowledge can influence NPD results (Chang & Cho, 2008; Cooper & Edgett, 2008; Tsai & Huang, 2008). This makes sense in virtual NPD teams, because the complex nature of the work requires more education, experience, creativity, and skill of the team members, which may reduce the leadership needed. NPD studies have shown the positive effects of team-member factors, such as prior ability, age, and prior experience (Chen & Askin, 2009; Marion & Simpson, 2009; Schmickl & Kieser, 2008). Strang (2009a) found that experience was a positive predictor (and the strongest) in virtual NPD team performance. Keller (2006) examined 674 team members, finding transformational leadership “initiating structure, and two of the substitutes for leadership (i.e., ability and intrinsic satisfaction) matter to R&D project team performance” (Keller, 2006, p. 208). Thus, in workplace teams, substitutes can be significant predictors of performance.

Professional orientation of the members could impact the NPD team result, as was noted in several relevant studies (Patanakul & Milosevic, 2008; Schmickl & Kieser, 2008). This approach makes sense, because many NPD teams are often composed of specialized disciplines, which could be indicated by the type of industry and experience. Organizational formalization (policies, procedures, rules) and/or organizational inflexibility could impact NPD team performance (Griffith, Harmancioglu, & Droge, 2009; Ngai, Law, & Wat, 2008; Oke, Idiagbon-Oke, & Walumbwa, 2008). Indicators of this might be linked to the project or industry type, the type of software used, such as sales force

automation (SFA), client relationship management (CRM), and other enterprise software modules, because the availability of these systems can improve the virtual communications and responsiveness to client needs (González, Mueller, & Mack, 2008; Kim, Kim, & Woo, 2008).

The cohesiveness of the team could be linked to cultural background similarity, personality characteristics similarities, and/or the amount of time spent working together on previous projects (Tan, Tyler, & Manica, 2008). The size of the team might also impact performance, because smaller teams would have fewer resources to simulate creativity, whereas larger teams might impede progress and decision making (Chang & Cho, 2008; Lin, Chai, Wong, & Brombacher, 2008). Organizational culture (policies, procedures, and customs) could impact NPD performance, which might be detectable by industry type, previous product success, and type of software used (Hemetsberger & Godula, 2007; Im & Nakata, 2008). Spatial distance between superiors and subordinates is not a factor that is differentiated in this research, because all teams are considered virtual; nevertheless, variations could be detectable by region. Finally, there is no concrete evidence that gender impacts NPD performance (Dobbins, Long, Dedrick, & Clemons, 1990; Sizoo, Malhotra, & Bearson, 2003), albeit some studies have noted that transformational leadership is rated higher (by team members) for females (Balthazard, Waldman, & Warren, 2009). It is not believed these factors will impact quality or time performance but they may serve as covariates and/or experimental controls. Nonetheless, gender and the above factors should be added as control variables.

Finally, as noted in the literature, not all virtual teams are comparable (Gassmann & Zedtwitz, 2003; Kayworth & Leidner, 2002). The virtual team typology of Gassmann and Zedtwitz (2003) can be applied to describe the NPD teams by increasing the degree of central project

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coordination: (1) decentralized self-organization, (2) a system integrator as a coordinator, (3) a core team as a system architect, and (4) a centralized venture team. They also point out that organizing virtual NPD (R&D) project teams is often based on four principal determinants: (1) type of innovation (radical/incremental), (2) systemic nature of the project (systemic/autonomous), (3) mode of knowledge involved (tacit/explicit), and (4) degree of resource bundling (complementary/redundant). Here this is applied as a descriptive characteristic rather than a factor.

NPD Team Personality Factors

There is growing empirical evidence that personality factors (either in the leader and/or followers) impact team performance (Judge & Bono, 2000; Judge, Bono, Ilies, & Gerhardt, 2002; Lim & Ployhart, 2004; Manning, 2003; McKenna, Shelton, & Darling, 2002; Ng, Ang, & Chan, 2008; Sankar, 2003; Sosik, 2005; Strang, 2009a). There is also a valid counterargument that personality instruments may not be reliable measures of leadership (Capraro & Capraro, 2002; Furnham, 1996; Kinder & Robertson, 1994; Michael, 2003). Nonetheless, the focus in this research is on how personality factors of the NPD team members impact their performance.

Personality factors are critical competencies for participants of e-business projects due to the multicultural team composition, and virtual communication context, which lacks face-to-face tactical feedback (Ashwin & Sanjay, 2004; Ngai et al., 2008; Strang, 2008). Personality factors such as extroversion, agreeableness, or even neuroticism likely impact team performance in a virtual technology-dominated context, such as modern NPD (Houghton, 2000; Strang, 2009a). In an experiment of teams that used online decision-making software, the leader was able to influence team members more than leaderless groups (Lim, Raman, & Wei, 1994), thus suggesting leadership may overpower team personality factors. One interesting

study by Balthazard et al. (2009) used the "Five Factor Model" (FFM, as described later) along with gender, team size, grammatical writing ability, participation level, and idea generation frequency to measure transformational leadership perceptions in virtual and campus teams of university students, but found very little predictive effect. Balthazard et al. (2009, p. 658) note, "Our findings pertaining to the predictive role of personality traits for the emergence of transformational leadership in VTs [virtual teams] contradict the findings of Judge and Bono (2000) [. . .] in virtual settings, personality, as it is conventionally measured, may not readily influence the formation of transformational leadership perceptions."

A few studies argue that personality characteristics substitute for, or moderate, leadership. Openness to change is a personality factor that has been linked to increased performance, as attributed to charismatic leadership (Conger & Kanungo, 1988; Jassawalla & Sashittal, 2000; Sankar, 2003), but it may be possible that it is instead an individual team-member personality (substitute) factor. For example, a study of virtual teams found that high levels of positive personal traits, such as communications (extroversion) and helpfulness (agreeableness, conscientiousness) increased team performance satisfaction (Kayworth & Leidner, 2002). Another study of virtual teams noted that higher extroverted behaviors resulted in higher outcomes, such as more electronic messages (Yoo & Alavi, 2004). Other personality traits may follow a similar pattern (Barrick & Mount, 1999; Furnham, 1996; Montoya-Weiss & Calantone, 1994), meaning that certain characteristics common in the team members may substitute for leadership and cause a positive impact on NPD team performance.

The creative nature and virtual context of NPD projects might favor leaderless team members who are extroverted, agreeable, and open to change (Aronson et al., 2006; Butler & Reese, 1991). On the other hand, one study of 33 research and

development teams found "support for innovation as a mediating process" (high support produced more innovation) and "climate for excellence" as a moderator of transformational leadership resulted in higher innovation (Eisenbeiss et al., 2008, p. 1444). Although mediation and moderation are not hypothesized in this study, these will be checked using visual (interaction) and statistical measures.

Another aspect of personality factors is the social desirability of all team members to "look good" and possibly make their peers and/or leader "look good" (or bad if they dislike them); this could be a substitute, moderator, or mediator. To some degree, this requires experimental control for bias and self-report factors, which is a challenge in leadership studies (Podsakoff et al., 1996, 2003; Yammarino, Dionne, Chun, & Danserau, 2005). On a cautionary note, Dionne, Yammarino, Atwater, and James (2002) sampled 49 organizations and concluded that leadership substitutes did not moderate or mediate outcomes, while suggesting past findings could be attributable to common-method bias. Nevertheless, by reverse-coding items and looking for extreme pattern levels in survey responses, social desirability bias can be reduced.

In NPD, several researchers have taken an interdisciplinary approach to measuring interpersonal competency effect on performance by adapting the personality "Five Factor Model" from individual psychology while also controlling for many of the confounding factors and bias (Buchanan, Johnson, & Goldberg, 2005; Cabrera, Collins, & Salgado, 2006; Kankanhalli, Tan, & Wei, 2005; Landers & Lounsbury, 2006; Liao & Chuang, 2004; Strang, 2009a; Taylor, 2006; Wang & Lai, 2006; Wasko & Faraj, 2006). FFM (sometimes called Big Five or NEO5) refers to the variability in normal personality in five dimensions: neuroticism, extroversion, openness to experience (openness), agreeableness, and conscientiousness. As noted earlier, personality traits are clearly related to NPD team competency

expectations. For example, conscientiousness includes the following facets: competence, order, dutifulness, achievement striving, self-discipline, and deliberation. Cabrera et al. (2006) found business team performance was related to the conscientiousness traits of reliability, dependability, industriousness, organization, and achievement orientation. In a similar study, conscientious individuals were dependable, responsible, hardworking, and achievement-oriented (Landers & Lounsbury, 2006). Conscientious team members tend to do what is expected of them (Liao & Chuang, 2004). In a similar fashion, the extroversion indicators of sociability and talkativeness might suggest team members would make friends with others, collaborate better (especially online), and seek out new sources of knowledge.

Agreeable people (with respect to personality traits) are cooperative, cheerful, and supportive of others, thereby motivating team members as well as accepting feedback. Openness has been linked to valuable NPD traits such as divergent thinking and creativity (McCrae & Costa, 1987), and by comparison, “closed individuals are not necessarily defensive, but they are more comfortable with the familiar and have little incentive to try the new” (p. 1259). Furthermore, openness has been found to be related to imagination, curiosity, artistic sensitivity, and originality (Cabrera et al., 2006), which are desired traits for NPD staff. Neuroticism is associated with anxiety, hostility, depression, self-consciousness, impulsivity, or vulnerability (McCrae & Costa, 1987), which are less preferred NPD e-business team traits. Although some literature has recast neuroticism as “emotional stability” (Buchanan et al., 2005), it is important here to be consistent with the *a priori* NEO5 and FFM (McCrae & Costa, 1987), which have been validated and empirically proven. From the above, the following hypothesis is suggested:

Hypothesis 2: Personality factors impact performance (as substitutes for leadership).

NPD Team Performance Criteria

Leadership is typically analyzed with the aim of demonstrating that it is effective, but the definition of “effective” varies. Most leadership studies delimit leadership effectiveness as satisfaction, either perceived by followers and/or stakeholders. For example, in a recent perceptual leadership distance study, the “team’s external leader, team members, and team customers were all asked to rate team performance using a four-item scale” (Gibson, Cooper, & Conger, 2009, p. 68). In other studies, NPD success is often measured by sales, market share, return on investment (ROI), and profit relative to targets. However, due to the difficulty of gaining accurate financial data, which would also be directly linked to immediate team performance, most researchers instead ask for estimates or perceptions (Ashwin & Sanjay, 2004; Belassi, Kondra, & Tukul, 2007; Chang & Cho, 2008).

Measuring leadership effectiveness using follower or stakeholder perceptions is a weakness argued here and by others (Werth et al., 2006). To confirm and/or refute that assertion in this sample, I randomly asked 13 executives in these multinational corporations what they considered measures of NPD leadership success. The unanimous answer was: design results (“time to market” or “design quality”). When I inquired further if “satisfaction” was a possible criterion for NPD project-leader success, the answer was “no,” because “customer satisfaction is important but it does not mean [NPD] business unit performance; satisfaction is a qualitative opinion . . . feeling a customer recalls about their purchase, or investor comfort level about their dividends.” Even if we had not asked these executives about their views on effective NPD leadership performance (or to acknowledge differences of opinion in the literature), it makes sense to use an objective metric (not subjective satisfaction), and the performance should be a project-level outcome (not perceptions of a project sponsor or team self-reflections

or longer-term organizational portfolio profitability).

According to the literature, time is an important benchmark for NPD performance (Mishra & Shah, 2009; Park, Lim, & Birnbaum-More, 2009; Sherman, Berkowitz, & Sounder, 2005; Swink, Talluri, & Pandejpong, 2006). Time pressure can make teams more productive, indicating that the pressure of time may drive people to get more done but it may reduce quality or scope if it causes them to think less creatively (Amabile et al., 2002). Creative thinking that is more oriented toward generating or exploring ideas such as in NPD (compared with other business projects) can be improved if team members collaborate within time constraints. Quality goals are often interrelated with NPD time and design scope requirements (Kim & Kim, 2009; Montoya-Weiss & Calantone, 1994); therefore, in NPD it is argued that time and scope measures are the most relevant at the project level because any other metric would not be reflective of the team outcome (Mishra & Shah, 2009; Strang, 2008). Salaries, budgets, or other levels of outcomes (e.g., organizational product returns on investment) do not directly reflect team outcome (instead they are program-level). Furthermore, this research and the survey were anonymous, plus employee performance data were not available (some organizations were reluctant to provide cost figures for earned value or competitive design information).

Research Methodology

This was a multiyear study that employed the hypothesis testing methodology on quantitative data gathered from *a priori* surveys and performance data. Figure 1 presents a diagram to illustrate the research design.

Subjects and Surveys

Eight medium-to-large corporations (each with at least 500 employees) in the marketing research, residential telecommunications, multiline insurance, and/or financial-superannuation

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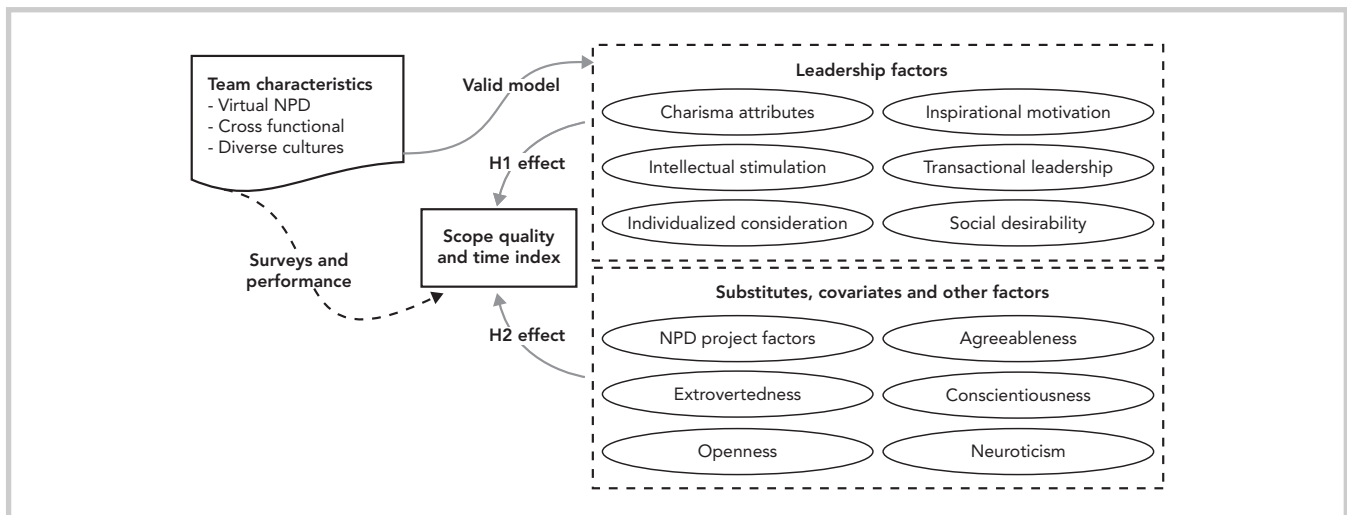


Figure 1: Hypothetical model of NPD project team leadership effect on performance.

industries voluntarily participated. All companies operated either a head office or business unit in Australia. Seven of these multinationals operated NPD project offices in at least two of the following countries: Australia, South Africa, United Kingdom, United States, New Zealand, Singapore, Japan, and India (the eighth virtual NPD project team was entirely located in Australia).

In this study, the final sample size was 1,358 team members. Participants were full-time employees from various NPD subject-matter expert positions, operating as virtual teams (across at least two geographic locations). All subjects worked in the English language (many spoke other languages and were born in different countries as compared to their work site); in addition, all had degrees from English-speaking universities. Demographics and descriptive statistics are summarized later to help readers understand the composition of the sample teams. The projects typically encompassed early NPD phases (needs analysis, ideation, and/or conceptual design), so the 0.8 years mean duration is lower than the 2.0 years finding in the Product Development Management Association Best Practices Survey (Barczak, Griffin, & Kahn, 2009, p. 7). Since these were virtual NPD teams (albeit across four different industries),

they were similar in structure. According to the virtual team typology characteristics (Gassmann & Zedtwitz, 2003), these samples were all centralized venture teams but the determinants were not assessed (these data were not available from all companies).

Data were first collected through an online survey to gather demographic information and capture responses on the five leadership and six personality dimensions. Leadership was assessed using adapted items from the MLQ5X-Short (B. Bass & Avolio, 1990, 2004). Item choices used a 5-point ordinal response scale (1 = *strongly disagree*, 2 = *disagree*, 3 = *neutral*, 4 = *agree*, and 5 = *strongly agree*).

Personality (substitute) factors were assessed using items adapted from the FFM NEO-PI-R (McCrae & Costa, 1997). The same response scales as MLQ (1 to 5) were used. Approximately half of the items in each facet group were reverse-coded for bias control.

Social desirability was measured using the Social Desirability Scale (SDS) short-form survey (Crowne & Marlowe, 1960). SDS includes 13 items on a 7-point Likert scale (1 = *strongly disagree* to 7 = *strongly agree*). The SDS is arranged so it can measure the degree to which a respondent is answering in an espoused "socially desirable" manner. The SDS

was used to detect outliers with extreme high means for the first factor and extreme low means for the last two factors (Fisher & Katz, 2000; Reynolds, 1982). It was also assumed that NPD team members would naturally have moderate to high levels of SDS. All response choices used a 5-point Likert-style scale where 1 indicated *strongly disagree*, 2 was *disagree*, 3 was *neutral*, 4 was *agree*, and 5 was *strongly agree* (SDS was adjusted from the original 7-point to a 5-point scale matching the other instruments to facilitate survey consistency, as well as reporting descriptive statistics and coefficients).

Factors and Variables

The MLQ items were tested for reliability and then summated into their factor means. FFM and SDS items were combined and in a similar fashion tested for reliability then summated into the factor means outlined earlier. The other substitute factors were taken directly from the organizational data supplied by the companies, except for the two performance variables (discussed below), which were calculated from the project data. Multivariate performance indicators are more powerful scientific indicators of effective team leadership (Stewart, 2009), so they were chosen for this study.

Time Performance Index (TPI) is an NPD ratio engineered using this formula (specified as SPI_t in Strang, 2008): Planned effort days/actual effort days (where dividing by zero is zero). Although TPI can be interpreted much like Schedule Performance Index (SPI) or Cost Performance Index (CPI), it is fundamentally different. TPI is an “end-of-project” performance ratio used in e-business NPD program management to benchmark time performance (yet also applies during projects). SPI is an earned value ratio used “during” projects to benchmark schedule efficiency (calculated using the formula: “EV [earned value]/PV [planned value]”), whereby an “SPI greater than 1.0 indicates the project is ahead of its planned schedule” (Project Management Institute, 2008, section 7.3.2.1). The problem in using SPI for benchmarking projects is it becomes 1.0 at completion (even if the project completed is late and over budget). [Correction made here after initial online publication.] Additionally, SPI and CPI are not indicative of performance “during” the later stages of the project, because everything can be very late but still produce high values. Misleading SPI can result from its formula, which assesses direct and indirect costs, potentially including expensive project assets, but not team-effort days. For example, if expensive consultants were heavily loaded on project tasks in the first half of the critical path, and if these had already been completed and/or expensive project assets had been acquired on schedule (e.g., software, machinery, buildings, or intellectual property), this could inflate SPI on a NPD project that was severely impaired or make a project look successful that was drastically behind schedule (and failing).

The Scope Defects Index (SDI) is an NPD end-of-project benchmark ratio calculated using this formula (Strang, 2009a): $1/[WD \times e + SCR] + 1$. The “WD” refers to total design Work Defects, $e = 2.718$ and is a mathematical constant in the expected value inferred from Poisson or exponential statistical distributions (Aliaga & Gunderson, 2003), and

SCR means NPD Scope Change Requests. NPD work defects were deliverable non-conformances (insufficient quality) that required additional rework. SCR were “official changes” (due to external factors or the wishes of the stakeholders) raised to the project sponsor and approved. The effect of this formula is to penalize work defects more so than scope changes (the latter of which are officially sanctioned by the sponsor, yet a high SCR does imply poor project owner planning). SDI is usually improved by NPD team experience and effective project management. SDI is decreased by factors such as poor research, uncooperative team work, new legislation, inadequate client relationship management, defective work, sponsor scope changes, and so on. It is desirable to have a high value of 1 for SDI, indicating good NPD scope and quality management.

Statistical Techniques

The hypotheses will be repeated along with the chosen statistical technique(s) used to test them. The confidence levels were set at 95%. In all cases, first descriptive statistics were used to illustrate the sample demographics (means and SD of key factors and variables). Correlation analysis was also applied to highlight preliminary relationships between the factors and variables. As noted earlier, mediation and moderation are not hypothesized, but these will be checked using visual interaction, multicollinearity, and auto-regression.

- *Hypothesis 1: High transformational leadership results in high NPD team performance*—Confirmatory factor analysis was used to validate the MLQ, whereas best-subset multiple regression and then MANCOVA were chosen to test the significant MLQ and leadership substitutes factors for predictive effect on TPI and SDI (this was accomplished with the significant personality and control factors configured as covariates).
- *Hypothesis 2: Personality factors impact performance (as substitutes*

for leadership)—FFM and SDS factors were integrated, then confirmatory factor analysis was used to validate this construct; best-subset multiple regression and then MANCOVA were chosen to test the significant FFM and SDS factors for predictive effect on TPI and SDI (this was applied using significant leadership substitutes and control factors configured as covariates).

Results and Discussion

First, the theoretical construct validity is reviewed, then hypothesis testing is discussed using the results from the best subsets multivariate regression and MANCOVA analyses.

Instrument Reliability

First, MLQ, FFM, and SDS factors were validated (as noted earlier, the last two were combined). Because several team members rated a single NPD team leader, interrater reliability, as a property of the testing situation, was examined for construct validity. A consensus estimate was used (instead of consistency or measurement). Because the goal was to summarize the team ratings by leader, the scales were a 5-point ordinal, and there was no interest in preserving or analyzing interrater deviances (Stemler, 2004). The kappa interrater reliability (Cohen, 1968) statistics for MLQ leaders ranged from 0.42 to 0.90 and from 0.49 to 0.91 for FFM + SDS—these are acceptable coefficients (Cohen, Cohen, West, & Aiken, 2003).

Pearson correlations were also produced for each factor (grouped by instrument) to highlight any cross-factor relationship. The abbreviated results are shown in Table 1 (only the three main instrument correlations were listed because there were no other significant intercorrelations;¹ descriptive statistics of mean and standard deviations are listed in Table 2 to conserve space). Previous research suggests some correlation should be expected between the

¹Full correlation matrix available from authors (please e-mail the author at kenneth.strang@gmail.com).

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Factors		Scale Intercorrelations (Alpha Reliabilities on Diagonals; $n = 1,358$)									
Leadership											
Charisma	{0.69*}										
Inspire	+0.411***	{0.66*}									
Stimulate	+0.531***	+0.535***	{0.67*}								
Consider	+0.413***	+0.511***	+0.499***	{0.61*}							
Transact	+0.112*	−0.029*	−0.011*	−0.479**	{0.88*}						
Personality											
Neuroticism	+0.414***	−0.328***	−0.314***	−0.171*	+0.014*	{0.62*}					
Extrovert	+0.202*	+0.269*	+0.131*	+0.071*	−0.352**	−0.069*	{0.76*}				
Openness	+0.317**	+0.265*	+0.212*	+0.275**	−0.117*	−0.065*	+0.212*	{0.72*}			
Agreeable	+0.212*	+0.277*	+0.099*	+0.214**	+0.312**	+0.077*	+0.099*	+0.214**	{0.89*}		
Conscience	+0.315**	+0.129*	+0.230**	+0.079*	+0.415**	+0.129*	+0.230*	+0.071*	−0.011*	{0.77*}	
Social desire	+0.123*	+0.104*	+0.209*	−0.005*	−0.411**	−0.055*	−0.009*	−0.005*	−0.071*	−0.011*	{0.71*}
* $p \leq 0.05$. ** $p \leq 0.01$ *** $p \leq 0.001$.											
Table 1: NPD leadership and substitutes factor intercorrelations and reliabilities.											

Table 1: NPD leadership and substitutes factor intercorrelations and reliabilities.

MLQ transformational leadership factors, and likewise within the FFM + SDS construct. There were a few intercorrelations of interest such as +0.414 between charisma and neuroticism (meaning high neuroticism relates to rating leaders as highly charismatic). The most interesting result was the correlation between transactional leadership and several variables—neuroticism (+0.014), extrovert (−0.352), agreeable (+0.312), conscience (+0.415), and SDS (−0.411)—which implies some correlation pattern between contingent reward/laissez-faire management and most personality factors.

Finally, each instrument was analyzed by ordinal factor analysis (OFA) with Varimax rotation (orthogonal), because the research goals were data reduction and summation (average) of the items to produce a factor mean instead of using the loadings, thereby making the results more understandable for other researchers (Strang, 2009b). All item loadings for each factor over both instruments were close to or above ± 0.50 (most were above ± 0.70 on the correct dominant factor), which were acceptable

in OFA (Jöreskog, Sörbom, & Wallentin, 2006). The MLQ had alpha reliabilities ranging from 0.61 to 0.88, which, although some were barely acceptable by the popular 0.70 benchmark (Cronbach & Snow, 1981) and lower than mainstream leadership research (Avolio, Bass, & Jung, 1995; B. Bass & Avolio, 2004), were accepted here. To qualify this decision, internal reliability benchmarks for validating *a priori* instruments vary from ≥ 0.80 (Davis, 1995) to ≥ 0.70 (Nunnally, 1978) to ≥ 0.65 (DeVellis, 1991) to ≥ 0.5 for new attitude/perception studies (Tuckman, 1999). The FFM and SDS factors had slightly higher alpha reliabilities, ranging from 0.62 to 0.89, yet only the neuroticism scale was below the 0.70 benchmark; thus, all were accepted as convergent, and discriminant construct validity was now established.

Hypotheses Testing Results and Discussion

Best-subsets multiple regression on SDI and TPI was used to select the most significant NPD performance predictors from all available leadership factors, substitutes, mediators, and controls. It is

well known that this technique has caveats, especially when using a large sample size (that will exaggerate regression), and the routines use an artificial approach to qualify predictors (not a theoretically meaningful algorithm). Nevertheless, the results, as shown in Table 2, very clearly indicate certain factors that significantly predict both the SDI and TPI dependent variable outcomes, and this makes theoretical sense.

The first observation from Table 2 is that “evaluation” was a key factor selected in every model (this represented average team project performance reviews in the last 2 years, as this much history was available from all organizations). Considering the increase of adjusted r^2 from model to model, and that evaluation was the only consistent factor, this confirms its effect on both SDI and TPI. The last model is the best one, based on the adjusted r^2 for 96.9 (SDI) and 96.8 (TPI), which included the following 12 factors: inspirational motivation, individual consideration, transactional leadership, neuroticism, extroverted, openness, consciousness,

social desirability, experience, evaluation, and projects. Experience was included; although it was not selected in the best model for predicting SDI due to its pervasiveness in other models, it was selected for predicting TPI and theoretically it was a probable factor. It could be argued that model 5 does not statistically gain much variance from model 4, but it requires two less factors along with a small increase in adjusted r^2 , which establishes it as a better parsimonious outcome.

Now with the 12 factors selected from the best subsets multivariate regression, the next step was to calculate detailed estimates of the effects of these on SDI and TPI. Table 3 lists the multivariate estimates for each factor selected from the best subsets regression, grouped by the construct (leadership, along with personality and project level substitutes). The columns show the standardized beta coefficient (in comparable unit scales), standard error deviation, and t -test on both dependent variables (SDI and TPI). The VIF (last column) indicates interaction between the factors (multicollinearity). All t -tests were considered significant following the rule of $\geq \pm 2$ (Jöreskog et al., 2006), although several were slightly below this but acceptable (inspire, projects, and experience). All VIFs were acceptable for this research, but as highlighted in the table, evaluation (7.0) and projects (6.2) show obvious signs of multicollinear interaction with the other factors and each other, which explains the variance of SDI and TPI outcomes.

Factor auto-regression on each dependent variable was checked using the Durbin-Watson d estimate, because both indexes measure project performance over time. The d 's were low (0.15 on SDI and 0.17 on TPI), compared with the benchmark ≤ 2 (Levine, Stephan, Krehbiel, & Berenson, 2005), and acceptable. Because other researchers have found factor moderation effects by testing factor-by-factor interactions, we did likewise but found none (as the VIF

confirmed). In similar fashion, we relied on the best subsets, VIF, and Durbin-Watson d to pinpoint mediators (but none was found). However, we felt it best to test by grouping performance into high and low for each factor, to detect mediation or interaction across levels of performance, but no mediations or interactions were found in any factor in the model (except "evaluation," as discussed later).

Arguably the most important estimate in the entire multivariate model (Table 3) is the adjusted coefficient of determination (SDI-adjusted $r^2 = 0.969$, TPI-adjusted $r^2 = 0.968$). This high predictive capability (97% for SDI and TPI) is much larger than any known similar empirical study. It is argued that these significant findings are attributable to the inclusion of the substitutes and controls in the model, as well as the leadership factors, and using relevant project-level criteria (SDI and TPI). By comparison, the MLQ is able (at best) to capture 60% of performance variance (B. Bass & Avolio, 2004, pp. 22–23).

Because all insignificant factors had been removed from the model to generate these results, the betas directly provided comparable positive/negative estimates for each NPD performance variable (and there were several surprises). First, the leadership construct manifested only three of its five factors, and they were the least influential in this multivariate model. Inspire and transact had positive betas on SDI (0.003 and 0.004), but lower betas and one negative beta for inspire on TPI (−0.001). Consideration was not very strong for either SDI (0.001) or TPI (0.002). A theoretical interpretation of this is that leaders who inspire teams and use reward mechanisms in NPD projects will positively influence scope quality criteria (and slightly less so time performance). Interestingly, inspirational motivation somewhat decreases the project time performance index (lower TPI and SDI are less desirable). It has been noted that it is difficult to capture variance in transformational and transactional

leadership, because these two subscales are so tightly related that it is difficult to separate their unique effects (Judge & Piccolo, 2004). Thus, there may be some validity to the argument that personality factors of team members may be more relevant (as compared with leadership factors) to predict NPD performance.

The personality factors influenced SDI and TPI the most, because all (except SDS, as predicted) were larger than ± 0.003 , with most above 0.004 on both criteria (whereas only transact reached 0.004 on SDI). The first big surprise was the high positive beta of 0.009 registered for neuroticism on SDI, but registered −0.006 on TPI, meaning that team members with high neuroticism tendencies increased scope quality (a good finding), while decreasing the time performance (not so good). Extroversion (0.005, 0.003) and agreeableness (0.006, 0.008) were easier to explain because both were high and positive, which as predicted, indicate high levels of these qualities in team members and positively influence SDI and TPI. Openness was unusually high negative on SDI (−0.008) but moderately positive on TPI (0.004), which suggests that NPD staff who were open to change cause rework (lowering scope quality performance) but, on the other hand, increase time performance. Thus, if a project manager is forced to make a trade-off on this, team members with high levels of openness will cause twice as much scope-quality performance decrease compared with increasing time performance (so, acquiring staff with less openness seems to be the strategic choice here). A similar dichotomy exists with consciousness, because high levels negatively impact scope quality (−0.004) but positively impact time performance (0.004). Thus, one offsets the other, so project managers could base their preferences on which criteria were more important to stakeholders or which performance criteria (SDI or TPI) produced more bonuses or less penalties. It was anticipated (and asserted) the NPD team staff would have moderate

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Factors (<i>n</i> = 1,358)	Descriptive Statistics		Models (Factor Selected: S = SDI, T = TPI)				
	<i>M</i>	<i>SD</i>	1	2	3	4	Best
Leadership							
Charisma (attributed influence)	2.97	0.80					
Inspire (motivates)	3.51	0.62	T	S		S	ST
Stimulate (intellectually challenges)	3.46	0.68					
Consider (individual coaching)	2.94	0.93				S	ST
Transact (laissez faire and contingent reward)	3.95	0.69	S	T		S	ST
Personality							
Neuro (neuroticism)	0.84	1.02			T	T	ST
Extrovert (extroverted)	3.74	0.89		S	T	T	ST
Openness (open to change)	2.20	0.95			T	T	ST
Agreeable	3.98	0.83		T	T	T	ST
Conscience (dutiful)	2.80	0.80			T	T	ST
Social desirability marker	3.19	1.07			T	T	ST
Individual							
Age (team-member age at end of project)	41.6	6.78					
Gender [male (m); female (f)]	39% f	61% m					
Experience (years in this NPD project industry role)	5.44	2.50	S	T		T	T
Evaluation (last project performance review's mean)	0.77	0.21	ST	ST	ST	ST	ST
Project							
Projects (number completed with same team)	2.21	1.18	S	T		T	ST
Team size (this project at end)	3.33	1.77					
Region (multinational and main project office)	4.68	2.86	T				
PM age (at end of project)	49.7	2.21					
Industry (four industries, quartiles [q] about even)	23%q1	27%q3		S			
Products (services, goods, launched in market)	2.68	1.81					
SFA (sales force automation software used)	2.87	0.86				T	
CRM (client relationship management software)	3.04	1.35				T	
Dependent variables	<i>M</i>	<i>SD</i>	Adjusted <i>r</i>²				
Scope Defects Index (SDI)	0.82	0.11	52.3	77.8	95.6	96.1	96.9
Time Performance Index (TPI)	0.83	0.13	49.9	80.4	95.9	96.0	96.8

Table 2: Leadership and substitutes best-subsets multivariate regression.

Factors (<i>n</i> = 1,358)	Scope Defect Index (SDI)			Time Performance Index (TPI)			VIF (all)
	Beta	SE	<i>T</i>	Beta	SE	<i>T</i>	
Leadership							
Inspire	0.003	0.001	4.1***	−0.001	0.001	−1.9*	2.3
Consider	0.001	0.000	3.9***	0.002	0.000	6.9***	1.1
Transact	0.004	0.001	7.7***	0.002	0.001	3.1***	1.8
Personality							
Neuro	0.009	0.001	13.3***	−0.006	0.001	−7.3***	1.7
Extrovert	0.005	0.001	6.3***	0.003	0.001	2.7**	1.7
Openness	−0.008	0.001	−10.1***	0.004	0.001	4.2***	2.0
Agreeable	0.006	0.001	6.8***	0.008	0.001	7.6***	1.8
Conscience	−0.004	0.001	−4.0***	0.004	0.001	3.3***	2.0
Social desire	−0.002	0.001	−2.9**	0.002	0.000	4.0***	1.1
Project							
Evaluation	0.013	0.000	77.8***	0.011	0.000	62.1***	7.0
Projects	−0.002	0.002	1.9*	0.011	0.001	8.3***	6.2
Experience	0.001	0.000	1.9*	0.001	0.000	1.9*	1.4
Durbin Watson			0.15	Durbin Watson			0.17
Adjusted <i>r</i> ²			0.969	Adjusted <i>r</i> ²			0.968
*Accepted as <i>p</i> ≤ 0.05. ** <i>p</i> ≤ 0.01. *** <i>p</i> ≤ 0.001.							
Table 3: Multivariate regression of leadership and substitute levels on SDI and TPI.							

Table 3: Multivariate regression of leadership and substitute levels on SDI and TPI.

levels of social desirability, which was the case, but with some trade-offs similar to those listed earlier. High SDS negatively impacted scope-quality outcomes (−0.002), whereas correspondingly high levels of SDS improved time performance (0.002), so the rationale of consciousness to inform team selection also applies here.

Evaluation was by far the most influential factor in the entire model, with relatively whopping 0.013 SDI and 0.011 TPI betas. This indicates that NPD team staff with good prior project-performance evaluations will significantly and positively increase both scope quality and time performance criteria (albeit due to the high VIF they also inherently include some slight effects of other factors to predict the outcomes). Projects was an unusual

factor in that more working together (with the same team members) can slightly decrease NPD scope quality compliance (−0.002), yet more working with one another dramatically increased time performance (0.011). From this repeat projects factor it could be inferred that team-member familiarity increases efficiency (TPI) but can decrease effectiveness (SDI). Project manager (PM) experience had a minor positive influence on both SDI (0.001) and TPI (0.001), implying that PM experience increases NPD performance. Based on the above, PM could strategically select high-performing staff (with good personnel evaluations) that had worked together before, with high levels of extroversion and agreeableness but moderate levels of neuroticism, openness, conscientiousness, and social

desirability, to maximize both scope-quality compliance and time performance.

At this point, it is asserted that certain leadership factors and substitutes (namely, consideration, inspiration, transactional leadership, all personality attributes, evaluation, experience, and projects) impact SDI and TPI performance, capturing a large 97% of the cause-effect variance. While the above multivariate regression was able to estimate positive or negative influence (beta coefficients) and overall model variance captured, it cannot isolate specific factor cause-effect on both NPD project performance criteria. Furthermore, it is asserted from the best-subsets, VIF (factor interactions with experience and evaluations), while noting the lack of auto-regression or

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Factor (<i>n</i> = 1,358)	Scope (SDI)		Time (TPI)		MANCOVA F	Wilks' Lambda λ	Lawley-Hotelling T	Pillai-Bartlett V	Roy's GCR	Multivariate (Meta ²)
	SS seq	Eta ²	SS seq	Eta ²						
Leadership										
Inspire	0.215	0.012	0.145	0.007	35.018***	0.291***	1.784***	0.901***	1.261***	0.71
Consider	0.186	0.011	0.216	0.010	11.218***	0.388***	1.214***	0.752***	0.694***	0.61
Transact	0.222	0.013	0.203	0.010	36.397***	0.172***	2.842***	1.167***	1.647***	0.83
Personality										
Neuroticism	0.014	0.001	0.083	0.004	22.940***	0.831***	0.197***	0.173***	0.174***	0.17
Extrovert	0.007	0.000	0.007	0.000	36.426***	0.793***	0.257***	0.210***	0.240***	0.21
Openness	0.005	0.000	0.021	0.001	45.956***	0.750***	0.331***	0.252***	0.322***	0.25
Agreeable	0.006	0.000	0.024	0.001	29.760***	0.826***	0.209***	0.175***	0.202***	0.17
Conscience	0.003	0.000	0.004	0.000	5.468***	0.964***	0.037***	0.036***	0.022***	0.04
Social desire	0.002	0.000	0.007	0.000	8.580***	0.919***	0.088***	0.082***	0.079***	0.08
Covariates										
Evaluation	16.807	0.956	20.441	0.959	2907.78***	0.170***	4.899***	0.831***	4.899***	0.83
Projects	0.011	0.001	0.073	0.003	12.260***	0.980***	0.021***	0.020***	0.021***	0.02
Experience	0.012	0.001	0.000	0.000	2.684***	0.996***	0.005***	0.005***	0.005***	0.00

****p* ≤ 0.001.

Table 4: MANCOVA of leadership and substitute levels on SDI and TPI.

moderation, that evaluations and projects are more likely mediators of team-member performance. Thus, MANCOVA can be used to simultaneously test these factors while repositioning evaluations, experience, and projects as covariates to more precisely isolate the multivariate cause-effect association on SDI and TPI, which is summarized in Table 4.

MANCOVA was employed to estimate the levels of each factor (with all in the model) to determine the combined impact on SDI and TPI, while adjusting for the covariance effect of evaluate (past project success), PM experience (likely project-manager capability), and projects (how much team members worked together before). In Table 4, the key measures are the Eta² (which estimates dependent variable effect size using the coefficient of partial determination similar to adjusted *r*²), λ (multivariate MANCOVA discrimination coefficient), and Meta²

(multivariate version of Eta² effect size). Of the four multivariate predictive estimates, Wilks' Lambda λ was chosen to test the hypotheses: Lawley-Hotelling *T*, Pillai-Bartlett *V*, and Roy's GCR tend to result in the same decision, λ is most immune to violations of multivariate assumptions (it maintains the greatest power) and is recommended for large samples (Hair, Black, Babin, Anderson, & Tatham, 2006).

First, the covariates in Table 4 can be examined to free the subsequent discussion for the critical interpretation of the leadership and personality factors. Evaluation (past performance) was the decisive covariate, with huge multiple coefficients of determination effect sizes of 96% (on SDI) and 96% (on TPI). This corroborates the best-subsets regression of model 3 in Table 3 and leaves very little room for the other factors to explain the remaining variance. Thus, to obtain a realistic multivariate estimate, Wilks' Lambda λ (0.17) strength

of association was used to show that "evaluations" explained 83% of the multivariate variance between the levels in the leadership, personality, and substitute factors. This also reveals that the other covariates "projects" ($\lambda = 0.98$) and "PM experience" ($\lambda = 0.996$) had very little (but significant) discriminatory power in the model.

The personality factors were disappointing in the multivariate MANCOVA analysis, as compared with the three leadership factors. Conscience ($\lambda = 0.964$) and social desirability ($\lambda = 0.919$) captured small multivariate levels of variance. The remaining four personality factors explained low-to-moderate amounts of multivariate variance levels on SDI and TPI: neuroticism (17%), extroversion (21%), openness (25%), and agreeable (17%).

The inspirational motivation and individualized consideration components of transformational leadership simultaneously explained a large 71%

and 61%, respectively, of multivariate variance level impact on NPD performance criteria SDI and TPI. The greatest surprise was the large 85% multivariate variance in SDI and TPI, explained by transactional leadership. This implies that NPD leaders could increase SDI and TPI by leveraging contingent reward principles (recognition and/or remuneration for achieving milestones) and actually not leading (*laissez-faire*) unless critical incidents occur, whereupon active management-by-exception may be used to “correct” problems.

In comparison, some of these findings were roughly comparable with a rigorous and similar study of 118 teams (674 individuals) by Keller (2006). Keller also found that ability/experience (as a substitute) strongly impacted team performance (he used three dependent variables, although they were subjective ratings by project sponsors), but in his analyses, initiating structure (in transformational leadership) was also a significant factor.

In summary, the combination of confirmatory factor analysis and multivariate regression helped to first identify the significant factors within leadership, personality, and project-level/organizational, in terms of NPD performance impact. These results explained the 97% variance on NPD project performance (SDI and TPI). MANCOVA put a realistic lens on these results by pinpointing which factors actually impacted NPD performance the most, given that NPD team members had moderate personality traits and their past project performance could be used as a covariance to mediate (and further isolate standard error); the finding was that high levels of transactional leadership (along with consideration and inspiration) differentiated between successful NPD projects having high SDI and TPI performance and those that did not. Based on the above, the hypotheses can now be accepted, rejected, or partially accepted, as summarized below:

- *Hypothesis 1: High transformational leadership results in high NPD team performance* = rejected; instead, it was transactional leadership that resulted in higher team performance.
- *Hypothesis 2: Personality factors impact performance (as substitutes for leadership)* = accepted; two factors were reconfigured as covariates (past evaluations, experience) to uncover this.

Limitations

First, generalizability to other industries or contexts is the main limitation with this research. Second, all of the instruments were barely valid according to contemporary standards; researchers and practitioners should be wary of that. A uniform five-ordinal survey response scale was used (strongly disagree to strongly agree), which makes descriptive statistics less comparable with SDS empirical literature, yet this was done to improve clarity, consistency, and interpretation across constructs. The large sample size made it possible to detect these interesting multivariate effects, yet other researchers may find this challenging to accomplish using small samples.

Finally, it was difficult to cite relevant leadership and team performance studies (let alone compare their theoretical and empirical findings), which was problematic, because few studies (beyond the ones discussed) were comparable with this. Interestingly, Balthazard and colleagues (2009) compared transformational leadership (using the MLQ) in virtual ($n_1 = 127$) with face-to-face teams ($n_2 = 135$) while testing the personality traits as predictors (employing the FFM). They also attempted to control for gender and team size. The dependent variables were activity level (a 0/1 judgment set by the researchers to indicate meaningful utterances) and communication/expression quality (a 0–7 ordinal scale also scored by the researchers), and, surprisingly, they asked the followers to identify their leader (so as to indicate emergent transformational leadership) and recasted the NEO5/FFM

neuroticism factor as “emotional stability.” Nevertheless, they used hierarchical linear modeling to find that personality did not predict transformational leadership, although there were “large differences in levels of extroversion and emotional stability” (Balthazard et al., 2009, p. 659). Furthermore, although they controlled for gender, they concluded that “female participants tended to be rated as more transformational” (Balthazard et al., 2009, p. 659)—that assertion requires clarification and testing. Finally, their study used researcher-scored measures, and the teams were undergraduate business students brought together for a test using a chat session. Thus, studies like Balthazard et al. (2009) are not necessarily comparable with real workplace NPD projects.

Conclusions

This unique integration of leadership, personality, social desirability, and project-level factors, analyzed with confirmatory factor analysis, multivariate regression, and MANCOVA, provided an insightful perspective on virtual NPD team performance. Despite the lack of equivalent literature to compare with, the incremental results listed here did corroborate with existing leadership and interpersonal competency studies. The MLQ transformation leadership, NEO5 personality dimensions, and SDS social desirability constructs were validated (with lower reliabilities as compared with the literature). Best-subsets regression identified 12 significant predictors of NPD project performance: transactional leadership, consideration, inspiration, moderate neuroticism, extroversion, openness, conscientiousness, agreeableness, moderate social desirability, good prior personnel evaluations, repeat team projects, and PM experience.

The MANCOVA technique put a totally new perspective on transactional leadership (one that would have remained hidden had this strategy not been applied). This was accomplished by using team-member past project

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performance (along with PM experience and repeat projects) as covariates. This accurately accounted for the mediating effects of interpersonal skills, ability, and social desirability on project performance, thus allowing more accurate multivariate measurements of the leadership factor effects. The result was that transactional leadership (not transformational), along with consideration and inspiration, were very important factors in these virtual NPD teams and accounted for higher performance ($n = 1,358$). There is no doubt (or common variance bias) about the higher NPD project performance, because both dependent variables—Scope Defects Index (SDI) and Time Performance Index (TPI)—were calculated from separate project data provided by the eight multinational organizations. From a behavioral viewpoint, naturally, past performance influences future work, and good past NPD team performance may also be the result of teams having desirable personality trait levels.

From a sponsor/managerial perspective, these results show that, contrary to the popular literature (including studies by this author), transformational leadership is not necessarily needed in virtual NPD projects (as can be seen by the insignificant factors as well as the small beta coefficients). Instead, some degree of particular transactional leadership factors seem to be needed—namely, management by exception, consideration, and inspiration. This may be a favorable finding, because transactional leaders are typically more difficult to find and they are more expensive resources (as they require exceptional skill sets). Furthermore, these results suggest that sponsors/managers of virtual NPD projects should select team members who exhibit the following personality attributes: moderate neuroticism, moderate to high extroversion, moderate to high openness, and lower levels of conscientiousness and agreeableness, with a normative social desirability disposition. Obviously, it

would be difficult for a sponsor/manager to preselect NPD team members with these characteristics so it is recommended the NEO5 or similar instrument be used to test candidates, and likewise, the MLQ could be used to test project leaders, to increase the odds of acceptable time performance and scope quality levels. Finally, the implications are clear that good prior team member personnel evaluations, repeat projects together, and PM experience are positive factors. ■

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